taking into consideration the size, type, and length of the hose, the nozzle size, and the vertical distance from the pumper level to the point at which the nozzle is elevated, according to the principles of hydraulics presented in section II of chapter 4. The pump operator should be capable of arriving at the desired pump pressure within seconds after the layout is made and observed.

(3) When pumping from a substandard water system, pumpers of comparatively large capacity may collapse their intake lines if the flow into the system is less than the discharge capacity of the pump. In this event, the pump operator must watch the intake gage as well as the pressure gage, and regardless of the pressure maintained, should regulate the throttle so that the intake pressure does not fall below 5 psi. This precaution is taken to prevent a collapse of the soft suction hose (intake line) which would cut off the pumper's water supply completely. If the hydrants are of such limited capacity, small nozzle tips and fewer hose lines should enable continued operations. If the hydrant suction is weak the hard suction hose should be used. The suction pressure should not be permitted to drop below 10 psi. This will permit a 5 psi error in the gage accuracy without the danger of collapsing a water main.

c. Pumping from Draft. When pumping from draft, whether the source is a tank, a pond, a lake, or a moving stream, the intake side of the pumper should be located as close to the water body as is feasible (fig. 4-48).

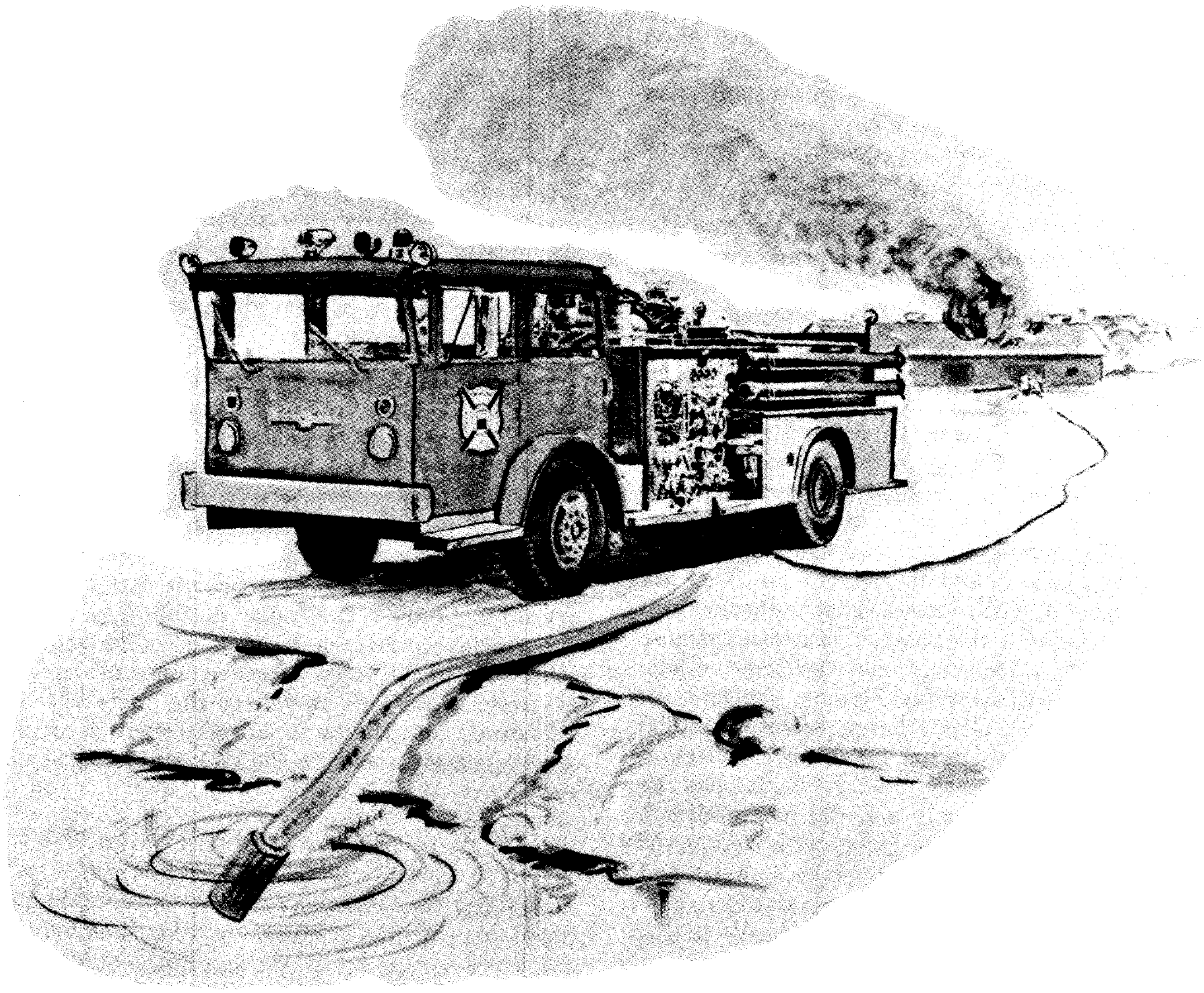

Figure 4-48. Pumping from draft.

(1) The location should have a solid foundation and be capable of bearing the weight of the truck and withstanding the vibration created by the engine and the pump. The pump lift, or the height from the water surface to the pumper, should not exceed 12 feet (3.66 meters) unless absolutely necessary. Shorter lifts are capable of producing greater overall volume and pressure efficiency. The emergency brake of the pumper must be set, the gearhift lever placed in neutral position, and the throttle opened only slightly to maintain a good idling speed. Check blocks are placed at the wheels if the vehicle is on an incline.

(2) Regarding the suction connections, the gaskets of the *hard* suction connections must be in place before connections are made. The suction strainer is attached to the end of the suction hose. A rope is secured to the suction strainer to facilitte handling, and tied into position. The strainer beneath the water surface is submerged to a depth of 18 inches to 4 feet (0.46 to 1.22 meters), depending upon the depth of the water source and the capacity of the pumps. Where the depth of the water permits, the strainer should be at least 12 inches (0.305 meter) above the bottom.

(3) If the water is too shallow to allow the suction line and strainer to be suspended in it and if the bottom of the water source contains sand and debris, the strainer must be protected to prevent debris from entering the pump. Lumber sheeting, sheet metal, boxes, the blade of a shovel, or any other flat container or object may be placed underneath and around the suction strainer to keep it clear. The strainer should be tied into position with a rope to prevent it from drawing air. If it is impractical to use rope, a large board or some other heavy material is placed over the suction strainer to keep it submerged. All openings are closed including drains and booster connections on the suction side of the pump. The necessary hose couplings are attached to the discharge outlets. When priming a centrifugal pump, the first requirement is that all discharge valves be closed and intakes, except the one being used, be tightly capped. The primer should then be started and the valve between the primer and the pump opened. When the pump is primed (filled with water) the pump should be engaged, the primer stopped, and the discharge valve(s) opened very slowly to prevent loss of the prime. Once the pumper is discharging water, the pressure desired as well as the number of lines needed can be maintained by coordinating the inake and discharge pressures with slow and deliberate adjustments of the throttle.

(4) Centrifugal pumps may be equipped with either a relief valve or a pressure-regulator valve. A relief valve is set at the predetermined pressure ; then when a line is shut off at the nozzle, the backpressure at the pump opens a bypass valve which reroutes the water from the discharge to the intake side of the pump, thus preventing a water hammer. A pressure-regulator valve is set at a pressure determined by existing conditions. These conditions are governed by the number of lines being used, their lengths, and the size of the nozzle tips. When a line is shut off at the nozzle, the backpressure thus created at the pump actuates a governor that reduces the engine speed and the pump pressure.

(5) When the pump is in operation the engine temperature must be watched constantly so as to maintain an efficient engine temperature of 160° to 180” F. (71° to 82° C). The temperature can be controlled by the cooling-water-supply valve. This valve is manipulated as often as necessary to maintain the desired engine temperature. However, the valve should never be suddenly opened or closed, for this practice heats or chills the engine too rapidly. The excess pressure coming from the fire pump is likely to damage the radiator or cooling system if the cooling valve is opened too far or too fast.

(6) Water is pumped from the boaster tank on the fire truck or trailer in much the same manner as it is from a hydrant. Since the water in the tank is above the level of the pump opening, the valve in the connection between the tank and the pump will permit water to flow from the tank to the pump by gravity, eliminating the necessity of priming. Because af this connection, care must be exercised to have the valve in this line closed when pumping from a hydrant or other gravity source of supply under pressure, since the excess pressure on the suction side of the pump will be introduced into the tank and will result in overflowing, causing leaks in the tank and other damage.

(7) As previously stated, it is not possible to set forth specific operating procedures for all pumps, but the foregoing will serve as a guide for the basic principles of operation. Almost all valves and levers on the pump are descriptively labeled. When they are not or when the nomenclature is not completely understandable, the pump operator

may, if he understands the purpose and principles of the operation, follow out each lever and each line leading away from the valve to its source and thus determine its specific purpose.

Section IV. ACTION ON ARRIVAL, SIZEUP, AND FORCIBLE ENTRY

4-37. Introduction

After responding to as few as a dozen fire emergencies the firefighter will be convinced of the great variation in fire conditions and the variation in procedure required to put out each fire. The first action of the firefighting crew immediately upon arrival at the fire is probably the greatest single factor in determining the success or failure of the operation. Enroute to the fire and upon arrival, crewmen must quickly analyze the part that each will play in the rescue and extinguishment procedures. The crew chief or senior man will make the basic assignments. Even after the assignments are made there is a great necessity for individual initiative in the details of execution. This initiative increases with experience and study.

4-38. Sizeup

The first duty of the crew chief and the crew is to "size up" or make a quick appraisal of the situation and determine what the conditions demand and the order of their procedures.

a. The following six conditions must always be taken into consideration :

(1) Life hazard involved or the rescue work required, if any.

(2) Exposure hazards from both the interior and exterior viewpoint.

(3) Type of building construction (consider the possibilities of collapse).

(4) Content hazards to both the occupants and the firemen.

(5) The accessibility of the fire.

(6) The type and amount of fire equipment required.

b. Whether persons occupy a burning building should be known before firefighting operations begin. Also, how many sleep there at night (if the fire occurs at night), and the facilities for exit and their condition, capacity, and usability. For example, open stair wells and fire escapes may be blocked by heat and flame, and elevators may be inoperative; if the roof over the elevator or its shaft is involved in fire, the elevator should not be used. On the other hand, stairways cut off at each landing, inclosed smoke towers, or horizontal exits into adjacent wings or buildings are likely to provide safe exits. Fires in buildings used for public assembly, such as theaters, dancehalls, clubs, schools, and hospitals, and for sleeping quarters offer the greatest life hazard.

c. The roofs and walls of adjacent buildings may be endangered by heat radiation or by an infiltration of heated smoke and gases from the initial fire, which may suddenly ignite or explode. Frequently the building or buildings exposed are more important to save than the burning building from the standpoint of life hazard, content value, or current need. Where the fire is well advanced, the first streams of water should be used to protect such exposed buildings. The direction of the wind, slope of the ground, distance between the buildings, extent to which the fire has spread and other considerations must be carefully appraised before action is taken.

d. Internal exposures from floor to floor via elevator shafts, open stairways, light walls, etc., must also be considered. When the fire is located in the basement or lower floor, prompt action in getting hose streams into operation at points where fire is apt to spread is an important means of making an effective fire stop.

e. The type of building construction is a factor which determines the time that fire will require to cause the collapse of a structure. This is important in determining whether a building can be safely laddered, and it will also determine whether men should be sent inside the building. Heavy timber construction will hold up under higher temperatures and for a longer time than unprotected steel. Reinforced concrete will withstand more weight of water than ordinary brick-joisted buildings.

f. Content hazards to the occupants and firefighters consist of explosive stock, toxic fumes, chemicals, acid carboys, compressed-gas cylinders, high-voltage wires, etc., which, when subjected to heat or hose streams, may jeopardize the safety of personnel. All of these hazards must be considered before ordering specific procedures for fire extinguishment. Knowledge gained during previous building inspections is of real value at such a time.

g. The characteristics of explosives should be studied, and, with the advice and assistance of the ordnance officer, advance conclusions should be reached regarding the time and heat necessary for detonation.

h. Toxic fumes require the use of compressed air, self-contained demand breathing apparatus.

i. Compressed-gas cylinders should have been previously inspected to learn the amount of pressure required to rupture them. Also, whether a cylinder is shatterproof should have been determined. The flammability, rate of expansion, and other pertinent properties of the cylinder contents should have been obtained so that the chemical reactions in the event of fire can be anticipated. liquid and powdered chemical reactions in the event of fire can be anticipated. Liquid and powdered chemicals must be respected from the standpoint of their gas-liberating qualities, the toxicity of the gas, the type of container (which may hasten or retard its release), and the general characteristics of the chemical when exposed to heat and water.

j. High-voltage wires can electrocute personnel over a widespread fire area where water is generally present. If the circuits are not cut off by the time water is used, extreme caution must be observed in stationing personnel during extinguishment. Personnel must be kept free of water which is in contact with sources of electrical currents.

k. Frequently mud, excavations, traffic jams, ditches across roads, blocked alleys, and a multitude of other obstacles prevent an approach to the fire from the most favorable direction. Previous knowledge of such conditions, which allows the crew chief to take alternate action, will prevent considerable delay.

l. In some fire emergencies it is possible, even before the firefighters reach the fire location, to determine that additional men and equipment will be needed. This can be judged by the nature and extent of the headway which the fire has already gained. When a large fire is observed in an area where no open fires should be found, a second alarm should be turned in as quickly as possible. This may be done from the alarm box, if one is available, or over a two-way radio. On small bases, where there are no firefighters available to respond to a second alarm, a thorough knowledge of available outside aid is invaluable.

m. In most responses or runs, it will be found upon arrival that there is no large fire, but rather a small fire consisting of something such as burning rubbish, automobile or furniture upholstering ; or oil overflow around the base of heaters. In such cases the crew chief should order one or two of his men to use the appropriate extinguisher or the booster line. The remainder of the crew should remain on the apparatus to await further orders.

n. In some instances firefighters arriving at the scene of a fire may find only an odor of smoke instead of an actual fire. If the source of smoke cannot be traced immediately and the odor continues, a thorough investigation should be made from the lowest level to the rooftop. Smoke frequently is blown into a building from the outside or may result merely from the temporary abnormal operation of a heating appliance, If there is any doubt regarding the source of the smoke, the firefighters will remain until the source has been discovered and corrective action taken.

o. When the sizeup discloses the need for immediate action, the following steps should be taken: Call for additional help (if required), initiate rescue work (if required), ventilate, locate the fire, close in, extinguish, salvage, overhaul, and investigate. Although listed in sequence, these steps are carried out almost simultaneously if enough personnel are available.

4-39. **Forcible Entry**

Forcible entry means gaining entry to closed spaces by opening locked doors and windows, roof, floors, skylights, partitions, and walls by mechanical means. Even the breaching of masonry walls with a battering ram and other extreme operations may be necessary. However, unnecessary destruction of buildings must be discouraged. Responsibility for careful, methodical forcible entry rests directly with the fire department. Forcible entry may be required for rescue, ventilation, control, or extinguishment and must be carried out with fast, methodical judgment, and tactics.

a. *Cutting with the Ax.* In cutting with a fire ax, short, quick, forceful strokes are used for better aim. Such strokes also prevent the ax from striking personnel and from catching in overhead obstructions, either of which is easily possible in dark or smoke-filled areas.

(1) Cuts are made diagonally rather than with the grain of the board (fig. 4-49) and as close to a joist or stud as possible. A proficient firefighter should be able to use the ax either right or left handed. Cutting in difficult corners and under obstructions can be efficiently done only by men who have been properly trained.

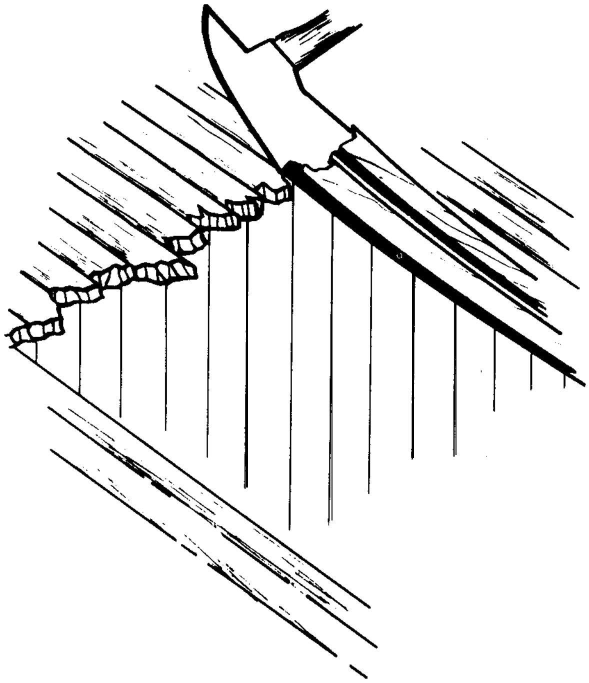

Figure 4-49. Cutting with the fire ax.

(2) Ax-made cuts in flooring, roofing, or sheathing are made at an angle of about 60° instead of straight down. Diagonal sheathing is cut in the direction the sheathing runs so that chips will tend to split out. If cuts are made against the sheathing, the ax may bind and require extra effort and time. Cuts through a lath-and-plaster wall are made in a direction diagonal to the grain rather than perpendicular to it. After the boards are cut, the pick end of the ax may be used for prying and removing them (fig. 4-50).

b. ***Types of Doors.*** The various types of doors must be understood by firemen before successful forcible entry can be made with the proper tools. The doors normally found on Army installations are ledge doors, panel doors, and industrial doors.

(1) ***Ledge doors.*** Ledge doors, sometimes called batten doors, are made of built-up material. These doors must be locked with surface locks consisting of hasps and padlocks, bolts, or bars. Hinges on ledge doors generally are of the surface type, fastened with screws or bolts.

('2) ***Panel doors.*** Panel doors may be either cross or vertically paneled. The panels are composed of thin material and dadoes are not glued into the stiles and rails. Either surface or mortised locks may be used, and hinges may have full surfaces, half surfaces, or hidden butts. The hinges usually contain loose pins, which are easily removed by a tap with an ax or a spanner wrench.

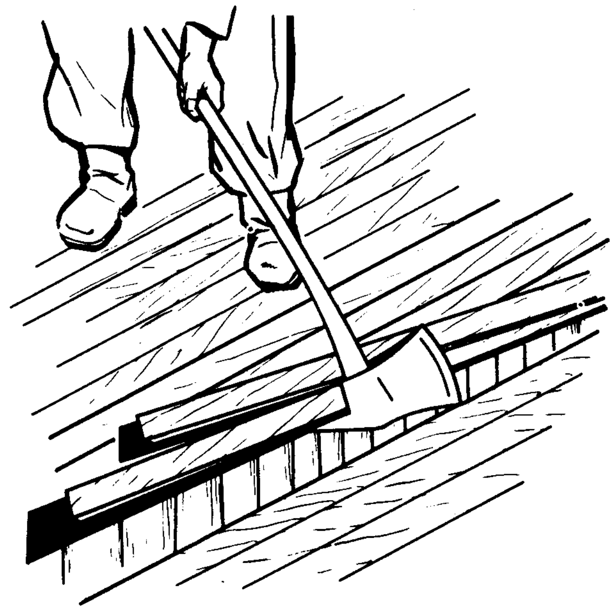

Figure 4-50. Prying with the fire ax.

Figure 4-51. Removing the hinge pins.

This avoids damaging the door or its casing (fig. 4-51).

(3) ***Slab doors.*** These are generally made of veneered hardwood with a white-pine core. They usually employ the same general hardware as panel doors, and, because they are solid, are not easily sprung.

(4) ***Industrial doors.*** Industrial doors are used in garages, warehouses, and storehouses, are double- and single-sliding, overhead-lift, or overhead-rolling.

c. ***Opening Doors.*** The method for opening doors is determined first by the manner in which the door is hung on the frame and then the way it is locked. Outside doors in barracks, store buildings, and recreation halls, and smaller doors of other buildings are set either against stops in the frame or against a rabbeted shoulder in the doorjamb. When using a door opener, insert the wedge just above or below the lock (fig. 4-52). A spanner wrench with a wedge end may also be used where a great amount of leverage is not required.

(1) Overhead-rolling doors are made of steel and offer the greatest resistance to forcible-entry tools. Normally, such a door cannot be raised except by operating its gear and chain. Prying on such a door may spring it so that the gear will not function. Sometimes a cast iron plate is installed in the wall near the chain. This plate can be broken to permit reaching the chain and raising the door in an emergency.

(2) If doors are only stopped in frame, the stop can be raised with a sharp wedge and the door swung clear of its fastening (fig. 4-53). When springing a door in a stopped frame with a door opener, use the tool to separate the lock and the jamb just enough for the lock to pass the keeper.

(3) When the door is set in a rabbeted frame, entry is not easily made. However, splitting the jamb or breaking the lock bolt with the door-opening tool will allow entry (fig. 4-54). To spring a door from either the stopped frame or the rabbeted frame, push the door open inward after the opener is completely inserted.

Figure 4-52. Using the door opener.

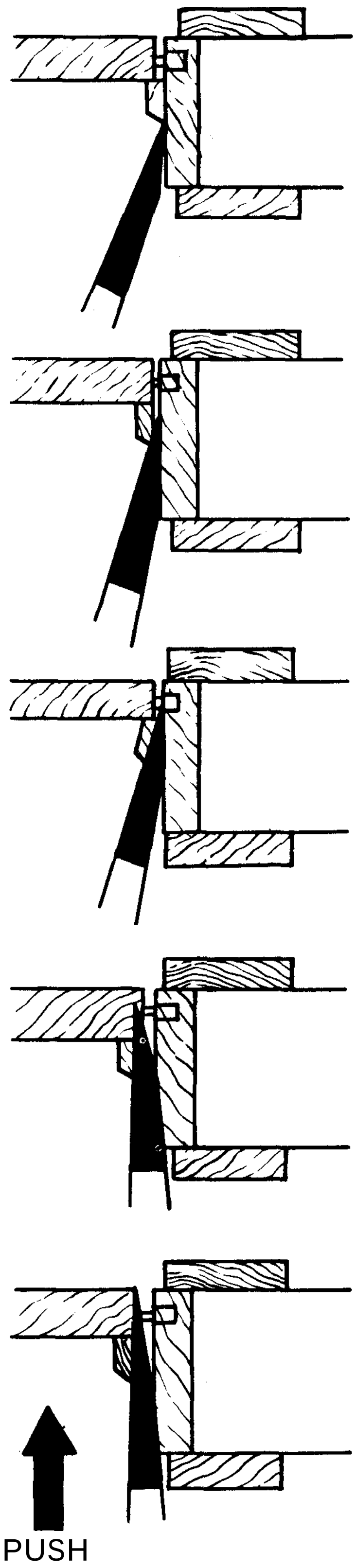

Figure 4-53. Springing a door in a *stopped* frame.

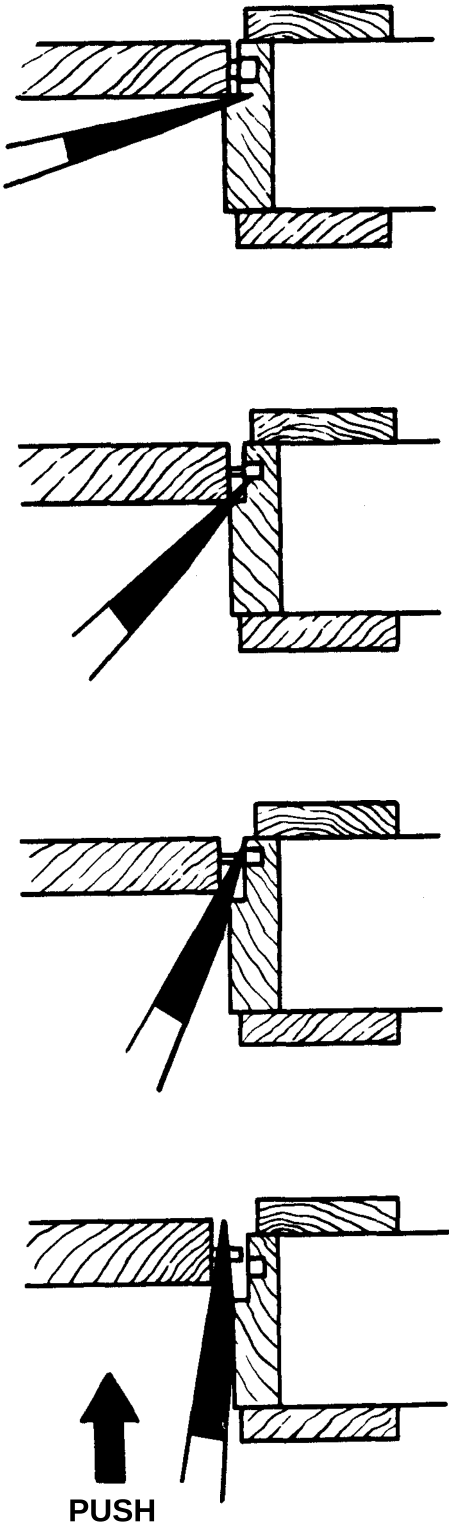

***Figure** 4-54. Springing a door in a rabbeted frame.*

(4) The same door may be opened with the wedge of an ax by inserting the blade above or below the lock and prying it to allow the bolt to pass the keeper (fig. 4-55). If this system is used, both the door and the jamb will be slightly damaged, but the door will close properly after the entry has been made.

(5) Double doors may be opened by prying between the doors until the bolt of the door clears the keeper. If an astragal, or the wooden molding, covers the opening, it must be set away before inserting the wedge.

(6) Night latches will normally yield to the same prying tactics as mortised locks. However, if

Figure 4-55. Opening a door *with a fire ax.*

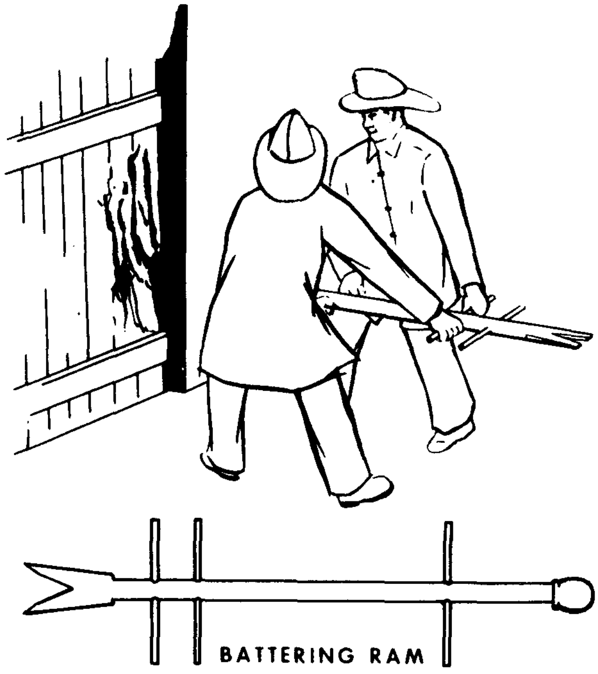

Figure 4-56. Battering ram.

they are fastened to the door with screws, they can be bumped off with a heavy obejct, such as a battering ram (fig. 4-56). When a battering ram is available, pushing a shoulder against the side of the door opposite the hinges will often spring the lock.

(7) Overhead-lift doors can be forced by prying upward at the bottom of the door with a crowbar or claw tool. After the lock bar is broken, the doors open readily.

(8) When single-hinged doors, such as those on houses and stables, are locked with a hasp and padlock, the staple of the hasp can be pried or twisted off with a door opener without damage to the lock (fig. 4-57).

(9) Many double warehouse doors are secured with a bar dropped into stirrups on the inside of the wall. In these cases, forcible entry is made by battering the door down or by making a breach in the wall with a battering ram. The breach is made at a point which permits slipping the bar from the stirrups. For ordinary brick walls, battering a hole large enough for a man to enter and unlock the doors from the inside is frequently the quickest and least destructive method of entry.

d. *Windows.* Prying with a wedge is the principal operation in forcing windows. The firefighter's ax, a claw tool, or any other wedge-shaped instrument may be used. If the wedge is wide and thin, entry can be forced with minimum damage.

(1) Factory type windows consist of steel sashes, which are often set solidly in the frame so that only a portion of the window may be opened. The movable portion is generally either pivoted at the center or hinged at the top and latched on the inside. Since factory type windows have small panes, breaking a glass near the latch becomes a fast, simple operation which causes negligible damage. Jagged pieces of glass left on the sash are cleared out before the hand is inserted. Wired glass must be completely removed from the sash.

(2) The check-rail window has two frames, or sashes, which are in contact at the top and bottom horizontals. If the window has no weights, the sash is locked with bolts in the window stiles or by a friction lock pressing against the window jamb (fig. 4-58).

(3) Check-rail windows can be opened by prying upward on the lower sash rail (fig. 4-59). If the window is locked on the check-rail, the screws of the lock give way, and the sashes separate. When the window is locked with spring-activated bolts, they must be broken or bent before the sash can be raised. Prying should be done at the center of the glass. However, if the check-rail

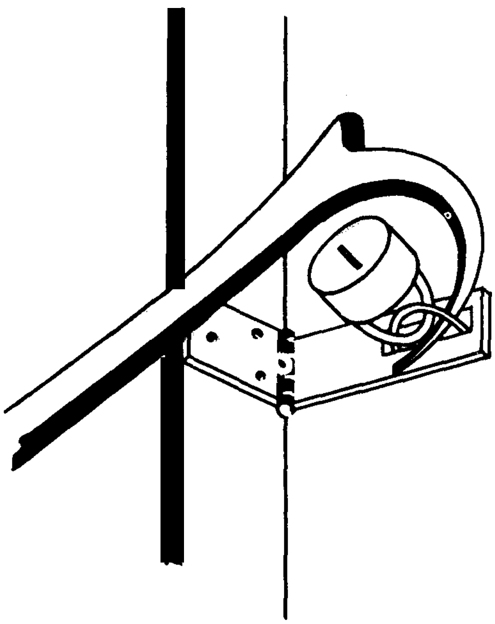

Figure 4-57. Using a door opener on a hasp.

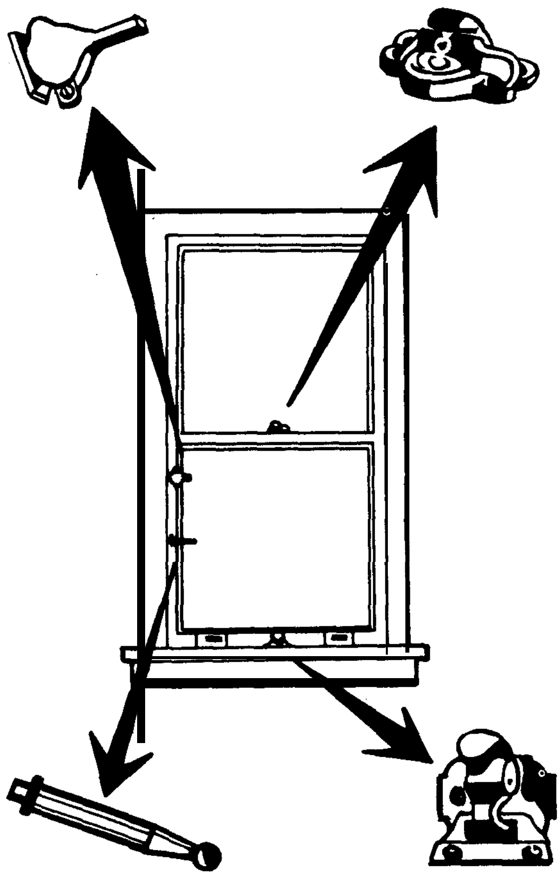

Figure 4-58. Locking devices for check-rail windows.

latch is on the side, the pry should be made directly beneath it.

(4) Basement windows may be opened in the same manner as a door in a rabbeted frame. If the prying is done at the center of the lower rail, the lock may be pulled or sprung.

(5) To open windows on upper floors, primarily to provide ventilation, the firefighter lies face down on the roof or leans from a window on the floor above and applies the point or hook of a pike pole to the window below (fig. 4-60). The pike pole can also be used to break the glass if the windown cannot be raised or lowered and ventilation is essential.

(6) Casement sashes are hinged to the window jambs and meet vertically ; they are locked either together or to the window frame. Casement windows can be opened in much the same manner as double doors. Generally, they are securely locked, and breaking the glass is necessary. Casement sashes of wood are generally hinged at the top and locked at the bottom; metal sashes may be hinged either at the bottom or at the top.

e. Roofs. Roofs may be classified, according to the construction of the covering, as shingle roofs, composition roofs, or metal roofs.

(1) Shingle roofs include all those made of small sections of material, such as wood, metal, or asbestos, fastened to the sheathing. Shingles are nailed to sheathing and can be removed easily. Shingle roofs can be opened by stripping off the shingles and cutting away the sheathing.

(2) Composition roofs contain from one to six sheets of roofing material, generally consisting of tarred felt nailed to the sheathing and cemented together with asphalt. Hot asphalt that hardens when it cools is spread over the entire covering. Gravel may be spread into and over the hot asphalt to become a part of the covering when the asphalt cools. The sheathing consists of l-inch (2.54-centimeter) shiplap laid tightly on wood joints or on solid concrete. Composition roofs require more care to open because they are more difficult to repair. The covering is cut and rolled back before the sheathing is cut away to make an opening. To locate joists, the roof should be sounded before it is cut. The cuts should be close to the joists to make both cutting and repair easier.

(3) Metal roofs, generally tinplate, consist of sheets of metal crimped or soldered together as one sheet. The sheets are fastened to the sheathing just as in wood construction under composition roofs. Successful ventilation frequently must be obtained by forcible entry tactics, When making an entry for ventilation, the firefighter should always work with the wind at his back so that gases and flames coming from the opening do not hinder or endanger him. After a roof is opened, the ceiling below is opened by forcing it down with a pike pole or other suitable tool. A ceiling is not usually difficult to push down from above.

Figure 4-59. Opening check-rail windows.

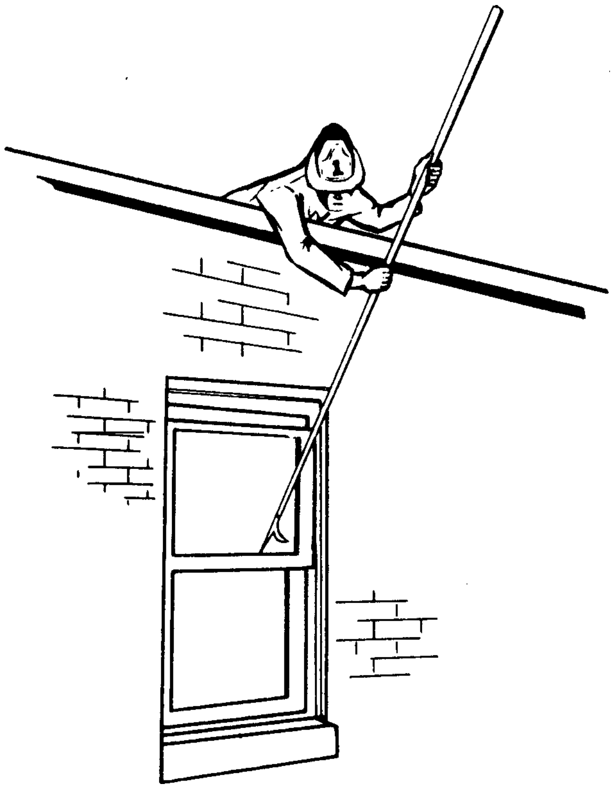

Figure 4-60. Using pike pole to open a window from above.

f. Floors. Permanent-construction wood floors are laid double on joints generally set on 16-inch (40.6-centimeter) centers. The subfloor is usually laid on a 45° angle to the joints, and the fop or finish floor at right angles to the joists. In mobilization type builclings, a single floor is laid directly on the joists, the joists set on 16-inch (40.6-centimeter) centers. In theather-of-operations type construction, a single floor is laid on joists on 24-inch (41-centimeter) centers. Floors may be openecl in much the same way as flat roofs, except that two distinct ctting jobs are required for double floors because the subfloor and finish floor run in different clirections. Joists are located by sounding, and both cuts follow the side of the joists toward the inside of the required opening. For efficient cutting, the hand which applies the force is held halfway up the ax hanclle. The feet are spread for proper balance and to avoid cutting the foot by a misplaced or glancing stroke. The man doing the cutting must be careful to stand outside the area to be opened

g. *Ceilings.* Plastered ceilings are opened by breaking the plaster and pulling off the laths. A pike pole of proper length is the most effective tool for this job (fig. 4-61). Metal and composition ceilings can be pulled from joists in the same manner. Board ceilings are somewhat difficult to remove because the lumber offers considerable resistance when an attempt is made to jam the pole through or between the boards to get a solid grip on the hook.

NOTE

Certain precautions must be observed when opening ceilings and walls. Do not stand under the areas to be openecl, pull downward and away to avoid being hit by falling material, and keep the upper hand on top of the pole to aid in pulling away. Always wear a helmet when pulling down a ceiling, since it is difficult to predetermine the amount of the ceiling which may fall after one thrust.

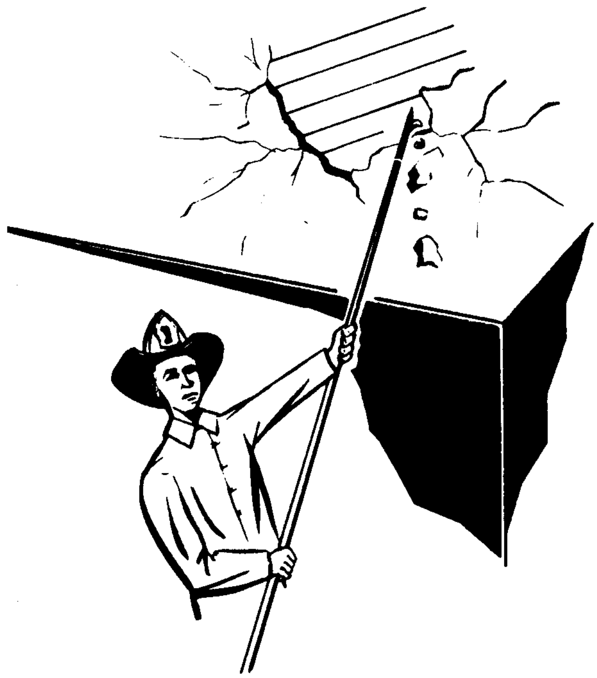

Figure 4-61. Removing lath and plaster ceiling.

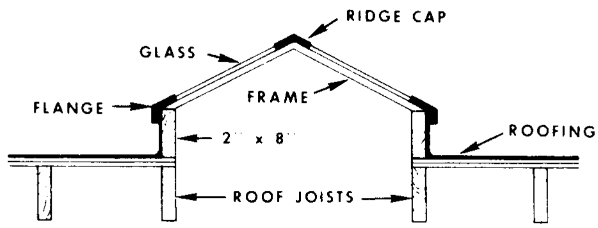

Figure 4-62. Section of a typical skylight.

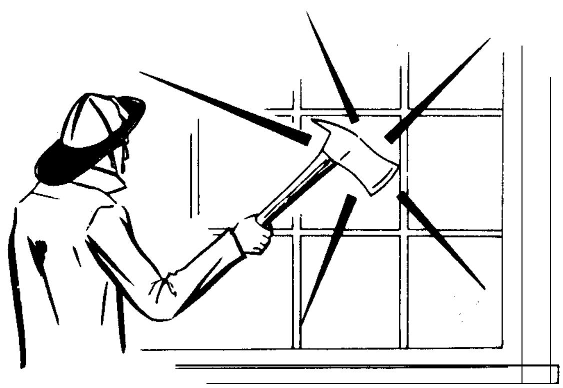

Figure 4-63. Breaking window glass with an ax.

h. Glass.

(1) The glass panes of a skylight are generally installed in a metal frame which slips over a flanged roof opening (fig. 4-62). By prying under the edge, the entire skylight can usually be pulled loose and removed, if necessary. If skylight cannot be liftecl, the glass panes may be taken out by releasing the metal strips that cover the joists and removing the putty.

(2) Glass in doors and windows is broken easily with the flat side of an ax. When breaking the glass, stand to one side and strike the upper portion of the pane first, being careful that broken glass does not slide down the ax handle (fig. 4-63). After the glass is broken out, remove all jagged pieces from the sash to safeguard personnel, hose, and ropes from injury and damage

when they pass through the opening. The jagged glass may be removed with the pick of the ax.

i. Tools. The proper way to carry tools is almost as important as knowing how to use them. Tools with sharp hooks or sharp edges should never be carried on the shoulder. If the carrier stumbles, he may release his grip on the tool, which may fall against him or strike another person. In the confusion, haste, and limited vision which normally accompany a fire, body contact is common, making an exposed tool a definite hazard. Sharp edges and points can be guarded best if tools are held in the hands. An ax, for example, is carried at about the level of the waist and held high in a horizontal position, with one hand grasping the handle near the head and the other hand covering the pick, Another effective method of carrying an ax is to hold it in a vertical position, parallel to the body, with the axhead upward, the blade almost beneath the armpit, and the hand covering the pick. In these positions, an ax can be easily thrown away from the body in the event of a fall. Tools with hooks, such as claw tools, are carried at the side with the hook forward. All tools with pointed and sharpened edges are carried in a like manner. A sense of safety is important in this respect.

j. *Other Types of Construction.* Local construction should be studied and preplanning done when construction varies from that described in this paragraph.

Section V. VENTILATION AND SALVAGE

4-40. Introduction

The problem of ventilation in burning buildings frequently presents great difficulties even to the experienced man. Salvage, including the prevention of excessive water damage, is another important factor in firefighting.

a. Unless firefighters have a technical knowledge of combustion processes, fuel characteristics, oxygen requirements, draft, effect of heat on air currents and building ventilation, and the principles involved in forcible entry, they cannot attack fires in buildings effectively and with reasonable freedom from danger. Principles of the chemistry of fires include many of the necessary facts, but ventilation introduces special variations. Ventilation includes removing smoke, gases, and heat from a building and controlling the fresh air supply to aid in rescues, protect the firefighters, and prevent the spread of fire.

b. The importance of salvage work done by firefighters cannot be stressed too strongly. Buildings and other combustibles are salvaged proportionately to the speed and efficiency of the firefighters and their ability to prevent water damage.

4-41. The Combustion Process

In the combustion process, fuels liberate carbon and hydrogen, the most common elements in burning materials.

a. A fuel exposed to flame or spark burns if it is heated to its ignition temperature if a sufficient amount of oxygen is present. The approximate ignition temperatures of the most common structural materials are as follows: dry wood, 500°F. (260°C.); paper, 450°F. (232°C.); pyroxylin plastics, 275°F. (135°C.); and cotton cloth, 440°F. (227°C.).

b. When fuels reach their ignition temperatures, they react with oxygen to form new compounds called the products of combustion. Moat of this oxygen comes from the atmosphere, which normally contain8 21 percent of oxygen. Some oxygen may be supplied by the oxygen content in cellulose materials such as wood, paper, and cloth. Free burning occurs when enough oxygen is present to consume the available fuel. For example, 1 atom of carbon (C) at its ignition temperature reacts with 2 atoms of oxygen (0) to form carbon dioxide (CO_2).

c. In a closed structure, enough oxygen is present when the fire starts to support free burning. Hot gases rise to the ceiling; this starts a consistent current and forces the cooler air downward to feed the fire from the floor. If fresh air is unable to enter the room from the outside, the amount of oxygen is gradually reduced until the fuel smolders and smokes. Theoretically, it should finally smother out completely; actually, however, the smoldering stage is sustained because in most cases the oxygen supply is never completely exhausted.

d. When the oxygen content of air is lowered, the rate and nature of combustion change: More and more of the carbon fraction reacts with simple atoms of oxygen to form carbon monoxide (CO), which, unlike carbon dioxide, is toxic and flammable. Sometimes fuels will distill, because of the extreme high temperatures, and join the atmosphere as hot, flammable gases.

e. Carbon dioxide, the common product of the complete burning of carbon materials, is neither flammable nor poisonous. The fire begins to smolder as carbon dioxide replaces oxygen in atmosphere of a closed room. In air having a high carbon dioxide content, the danger to personnel is the suffocating effect caused by lack of oxygen.

f. Carbon monoxide is a product of incomplete combustion. Carbon monoxide gas is more prevalent in unventilated buildings because of the lack of oxygen. It is an extremely poisonous gas, and air that has a content of 0.5 percent carbon monoxide causes unconsciousness guickly. Air containing 12.5 to 74 percent carbon monoxide may be explosive. The ignition temperature of carbon monoxide is 1128°F. (609°C.). The combined toxic quality and flammability of this gas make it very dangerous.

g. Burning hydrogen combines with oxygen to form water vapor. Burning sulfur produces sulfur dioxide, an irritating suffocating gas which is not flammable ; it irritates the eyes and respiratory passages and is dangerous to breathe in high concentration. Nitrous fumes include several oxides produced by cellulose nitrates.

h. Although the gases of combustion are mixed with the air, they are more highly concentrated at specific levels, depending upon their densities. Taking'air as 1.000, the following list of comparative densities will indicate the level at which these gases may be found : carbon dioxide, 1.608 ; carbon monoxide, 0.978; sulfur dioxide, 2.437; and nitrous fumes, 1.036 to 1.530.

i. Smoke is always produced when combustion is incomplete. Its density, color, and content vary with the oxygen supply, the intensity of heat, and the type of fuel being burned. Water vapor and particles of free carbon are generally found in the smoke; such fuels as pine may distill and give off dense black smoke. Oils, tar, paint, varnish, molasses, sugar, rubber, and sulfur may burn with such dense smoke that ordinary ventilation practices fail to clear the room.

j. If combustible materials are heated to extremely high temperatures in the absence of oxygen, the lighter fuel elements and compounds from the materials are distilled into fuel gases, These hot gases need 'only oxygen and a spark to burn with explosive violence. This explosive reaction is known as a back draft. Actually a back draft may be defined as an explosion that occurs when a large quantity of oxygen is suddenly admitted to an interior fire. This condition is generally met when ventilation is made initially on the windward wide of a burning building, especially when the wind is of high velocity and of sudden and large volume.

4-42. Evaluation

Careful evaluation of the situation is necessary before an opening is made to ventilate closed buildings. The fire chief estimates the situation by considering the rescue requirements, type of building and contents, smoke and heat conditions, and explosive hazards. He also takes into account the weather conditions, manpower and equipment available, safety precautions, and exposed buildings nearby.

a. One-story buildings with several rooms or compartments present more hazards than a single compartment structure of the same size. When hot gases rise to the ceiling, the cooler fresh air from adjoining rooms is drawn under doors or through other openings, permitting the fire to burn longer before it begins to smolder. As the hot gases and smoke fill the entire structure, it becomes difficult to find the exact location of the fire, and proper ventilation procedures become increasingly uncertain.

b. In buildings of more than one story, hot gases and smoke rise to upper floors through elevator shafts, stairways, air-conditioning shafts, and similar conduits. Reaching the highest possible level, the gases and smoke spread over the entire floor, eventually filling the building from the top down. This condition is commonly known as mushrooming, and can create great smoke damage even from a small smoldering fire. At the same time, oxygen is supplied to the fire from incoming currents of cool air. Smoke is generally seen coming from openings in the upper floors regardless of the location of the fire.

c. Figure 4-64 shows how the progress of a fire in a closed room occurs in four stages:

(1) In the first stage (A) the fire burns freely. Adequate oxygen is still available in the air, and water vapor and carbon dioxide are produced, along with small quantities of carbon monoxide and sulfur dioxide. The room temperature is about 100°F. (38°C.).

(2) In the second stage (B) the original pro-

portion of 21 percent oxygen in the air is reduced to about 17 percent. Burning has slowed, and carbon monoxide production has increased. The room temperature is between 300° and 400°F. (149° to 204°C.).

(3) In the third stage (C) fire is barely visible because the oxygen has been reduced to 15 percent. Carbon monoxide is produced in increasing amounts, and free carbon and unburned fuel form dense smoke. Heat of about 700°F. (371°C.) and gases imperil personnel and produce an explosion hazard.

(4) In the fourth stage (D) the fire is smoldering, with the oxygen content at 13 percent or less. The room is completely filled with smoke and gases at a temperature of about 1,000°F. (538°C.). This intense heat distills *a* portion of the fuels from the combustible materials; the fuel gases mix with other gases present, adding to the fire hazard. The danger to personnel and the probability of explosion (back draft) are extreme.

d. An idea of the intensity of the fire can be obtained from feeling the walls, doors, windows, and roof. Hot spots on walls and ceilings indicate the location of the fire or the path of the hot gases, A hot spot on the roof on a one-story building indicates the fire to be directly beneath it. A hot spot on the floor of a multistoried structure shows the line of travel of hot gases on the floor below.

e. When the method of attacking a fire is planned, the danger of an explosion from the admission of fresh air must be considered. Explosions which occur when fresh air is admitted to a smoldering fire are caused by rapid ignition of combustible material, gases, *or* both. Improper ventilation procedures generally lead to explosion hazards, and in some cases explosion hazards are

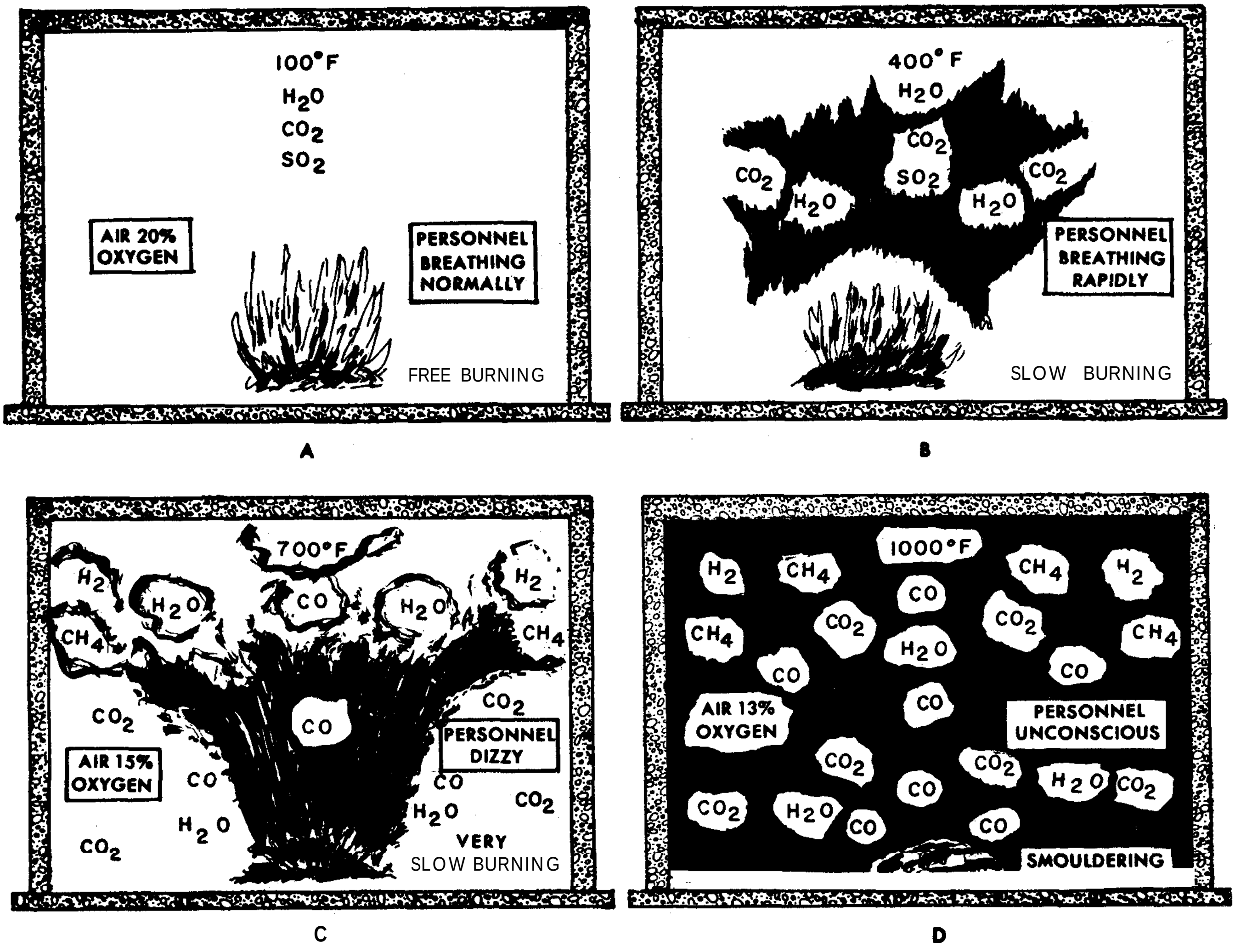

Figure 4-64. ***Progress*** *of* ***fire*** *in a* ***closed*** *room.*

not completely absent regardless of procedures. If the opening made for ventilation permits a sudden amount of fresh air to enter before the outward draft of fuel gases begins, an explosion will result if the mixture forms in proper proportions. When possible, openings should be made *above* the seat of the fire to avoid forcing a draft of fresh air directly into the fuel gases still trapped inside the building. Openings made near the fire, which permit large quantities of fresh air to become mixed with fuel gases before complete ignition occurs, are dangerous.

f. Since fire can be expected to spread rapidly as soon as an opening is made, adequate *protection* in the form of extinguishing agents must be provided, in advance, at points of intended entrance and at points of exposure to other structures. Enough charged hose lines must be advanced to extinguish the fire and provide an adequate standby reserve.

443. Safety Measures

Fire protection involves so many procedures which must be executed almost simultaneously that it is difficult to present one phase without mentioning a related duty. Consequently, advancing charged hose lines to the points of entrance becomes a significant part of the ventilation sequence.

a. A combination nozzle providing either a fog or a straight stream should be used. The fog stream is invaluable in clearing remaining gases and laying a curtain to protect firefighters from the intense heat. Since carbon dioxide, carbon monoxide, and nitrous fumes are soluble, this water vapor curtain dissolves and carries down much of the gas ahead of the firefighters. The standby hose should be brought into use only if the fire spreads as a result of an increased oxygen supply.

b. Before the burning building is opened, protective standby lines are advanced to other buildings that may be endangered if the fire spreads. These lines are charged and ready but are not used until they are actually needed. It may be necessary to advance some of these lines over roofs and perhaps inside adjoining buildings. Others may be laid to support floors of the burning building if the fire has not yet reached them.

c. Precautions for the safety of the fighters are of primary importance during ventilating procedures. Firefighters who take unnecessary risks not only endanger their own lives but also may handicap the department by becoming injured before the fire is extinguished. These risks, in turn, endanger the lives of others,

d. Air containing less than 15 percent oxygen will not sustain life, and atmosphere containing less than 1'7 percent oxygen prevents firefighters from working efficiently. Carbon monoxide and nitrous fumes in the smallest amounts may prove fatal. Compressed air, self-contained demand breathing apparatus are used where lack of oxygen is suspected.

e. Rope strung from the entrance to the smoke-filled area permits the firefighter to retrace his steps when the smoke is so thick that it permits only limited vision. After a hose is laid to the fire area, a rope becomes unnecessary, because the hose may be readily traced back to the entrance. Of sufficient importance to repeat is the necessity of using fog streams to absorb and settle combustion gases and disperse smoke.

4-44. Ventilating the Building

After the situation at the fire has been evaluated, and the necessary preparations made, the building is opened to permit hot gases and smoke to escape and to extinguish the fire in the shortest possible time. Proper ventilation should clear the building of smoke and gases and minimize smoke damage, allow crewmen to prevent further spread of the fire, and permit the extinguishing of the fire with a minimum amount of water.

a. Vertical Ventilation. If the internal ventilation, or the ventilation of an inside compartment, of a closed building permits smoke and gas to move to the uppermost level, an opening there permits gas and smoke to escape quickly into the atmosphere. This procedure is termed vertical ventilation. The exit opening is generally made in the roof. The following procedures are important in vertical ventilation.

(1) Check the condition of the roof supports to insure that they have not been burned away or weakened to a point where they may collapse under the weight of the firefighters.

(2) Plan a means of escape from the roof for firefighters who may be confronted with a possible emergency.

(3) Use any available natural openings, such

as scuttle holes, penthouses, and skylights, if they are properly located.

(4) Do not permit hot combustible gases to pass flammable materials which are already heated. Fresh air may enter the opening before the outward current is established, thus starting a new fire on the roof.

(5) Be certain that roof openings are extended down through the ceiling of the room.

(6) Make the openings large enough to provide quick exit for smoke and gases.

(7) Work on the windward side of the openings, keeping in mind the heat, explosive characteristics, and toxic effects of escaping gas.

b. Cross Ventilation. If smoke and gases have not reached the uppermost level, cross ventilation may be used to clear the building, one floor at a time. This method requires more care than vertical ventilation because large vertical shafts, such as open stairwells, may allow downward drafts of cross-ventilated fresh air to reach an area not yet opened, causing an explosion. Natural outside openings must be available on each floor level. The procedures for cross ventilation are as follows :

(1) Open the windows on the leeward side first; then open the windows on the windward side.

(2) If the windows are check-rail types, open the upper half on the leeward side and the lower half on the windward side.

(3) After one floor is clear, ventilate the next floor in the same way, or ventilate into the room already cleared if the room is not occupied by people.

(4) Do not make openings below the level of the fire.

(5) If the opening is made at the same level as the fire, the hose lines should be available for immediate use.

4-45. Entering

Before hosemen are directed to proceed with extinguishment, checks must be made to insure that enough heat, smoke, and gases have been removed to permit entering the building without casualities. When the intense draft set up at the exit openings cools or ceases altogether, the building probably is ready for entry.

a. After precautions have been taken against the spread of fire and the opening has been made for ventilation, the next step involves reaching and extinguishing the fire. Other openings are made as near the *fire* as possible, with charged hose lines held in readiness. These openings should never be below the base of the fire.

b. When firefighters proceed through smoke-filled rooms to locate the base of the fire, they advance behind a waterfog curtain if the smoke causes enough discomfort to warrant its use and if water damage will not be unnecessarily great. ‘This curtain tends to drive the smoke ahead of the personnel. Following the heat and smoke toward their point of greatest density is the best guide; feeling walls and fixtures and observing air currents are also helpful. The same safety and protective measures must be taken during extinguishment as are taken for ventilation.

c. It may not always be necessary to ventilate a building to locate a fire, nor is it always advisable to postpone ventilation until rescue work is completed. Actually, they go hand in hand, and when the number of available personnel is such that different operations can be carried on simultaneously, teamwork then takes the initiative, and hose lines are ready for use by the time the crew is ready to ventilate. Ventilation normally should be started at the top of the building and worked downward. Coordination in ventilation is an extremely important factor. When possible, it is advisable for the fire chief in charge to give the commands to ventilate. This minimizes the possibility of back draft or accelerated fire propagation, which may easily occur with several groups working without concern for each other.

d. A complete knowledge of such matters as the structural characteristics, arrangement, and contents of the building, acquired by previous inspections, is almost essential to successful ventilation. Basement fires are sometimes extremely difficult to ventilate because under some conditions the smoke is not hot enough to rise, which increases the possibility of explosion. Low-temperature smoke—produced by such materials as rubber, fats, and wax-is very persistent in resisting ventilation. Such smoke is also capable of dropping to lower levels. This condition usually requires mechanical aid, such as blowers, in addition to the normal procedures.

4-46. Salvage

Salvage work in firefighting consists of <preventing excessive damage by fire, smoke, and water.

Water often causes as much damage as the fire itself.

a. Water Protection. Improper arrangement of contents in a structure can cause large water losses. For example, shelves built up to the ceiling directly against a wall make salvage impossible, unless the contents are removed, because water flows down the wall, soaking the shelf surfaces and their contents. One common obstacle to efficient salvage involves material piled on the floor without skids. The lower portion of such piles is difficult to salvage when a large volume of water has been used for extinguishment. Materials stored in paper boxes or cartons frequently spill when the bottoms of the containers are wet, thus ruining the entire contents even if the boxes are covered efficiently and if dikes have been made with sawdust.

(1) Material stored on lower floors may be covered with large waterproof tarpaulins. If the quantity of material and weight is not excessive, it may be moved outside or to another part of the building. Heavy crates, packing cases, machinery, and similar articles should be covered. Metal should be wiped dry and oiled to prevent rust. Much water damage can be prevented by proper application of water at the base of a fire. Firefighters should watch for leaky hose connections and for the spray of water on dry material. When the fire has been extinguished, all floors should be cleared of water by sweeping it toward a door or opening. If holes must be chopped for drainage, the rate of damage is greatly increased.

(2) Foodstuffs must be protected against becoming tainted by exposure to smoke and water. Meat, solid fats, and cheese may have little or no salvage value if they are subjected to smoke or heat.

(3) When a roof has been damaged, the hole may be covered with a tarpaulin or roofing paper. Care should be taken to remove all nails and sharp objects to prevent damage to the covers. When the entire roof is destroyed, temporary roofs of canvas truck covers may be installed. The covers must be securely fastened.

(4) Further damage by water can be prevented by using sawdust to absorb water and to form dikes that direct the water outside through doorways or other openings. Wooden floors can be drained by drilling holes in them. When absorbent materials are involved, care is necessary to prevent the excess weight added by water from collapsing the floor. Firefighters should be trained to make a speedy estimate of the weight of water being used by calculating from the known nozzle size, the water pressure, and the length of time during which water has been discharged. A pumper discharging from a single 2½-inch (6.35-centimeter) hose line can deliver about 1 ton of water per minute.

(5) Articles of special value should be removed from the debris as soon as the fire has been extinguished. Debris should be removed from the building, floors swept, and excess water removed with broom and squeegees. Office records of administration buildings, headquarters, and similar buildings should be fully protected with canvas covers.

b. Salvage Covers.

(1) To permit convenient handling and easy manipulation, the 12 by 18-foot (3.7 by 5.5-meter) salvage covers are folded into an accordion fold (fig. 4-65). In this fold, the two ends are brought together in the center of the cover, which is then foided over double. Then lo-inch (25-centimeter) folds are made until the operation is completed.

(2) The large 14 by 18-foot (4.3 by 5.5-meter) salvage cover is folded somewhat differently from the small one because of its greater

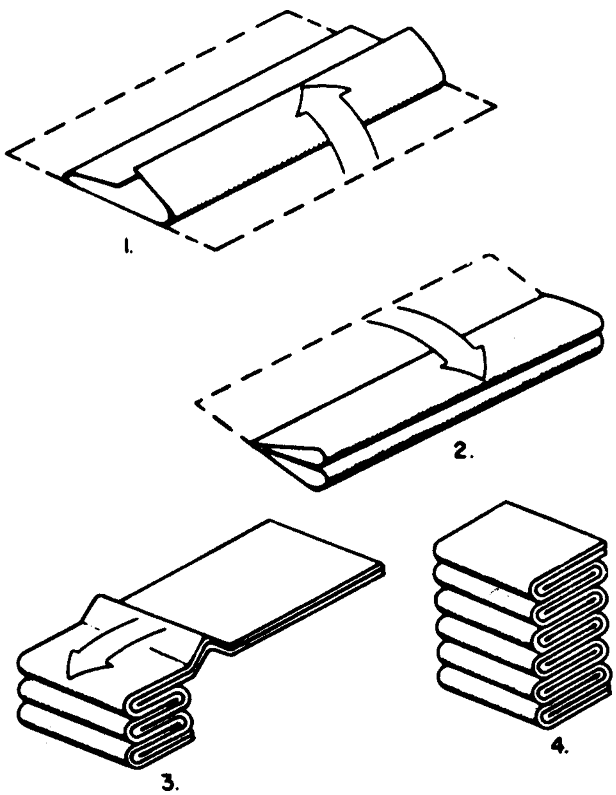

Figure 4-65. Accordion fold for small salvage covers.

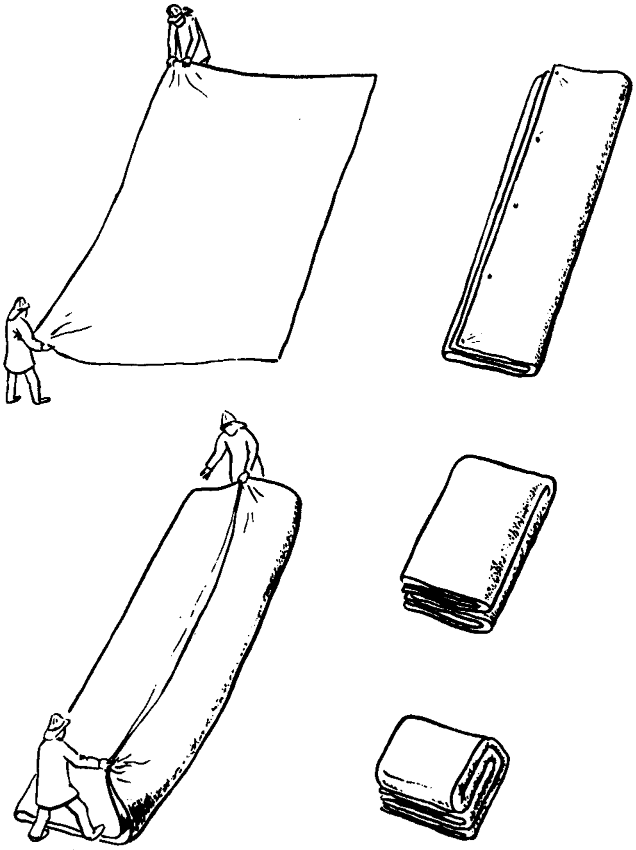

Figure 4-66 Two-man fold for large salvage cover.

size and weight. The fold for the larger cover requires two men, who position themselves at the two corners of one of the long sides of the cover (fig. 4-66). They fold the cover to the center, then fold it to the center again, bring the ends together, and fold the cover again lengthwise.

(3) The large salvage cover requires a one-man carry in which the cover is placed over the shoulder. This is done to keep the tops, which are secured in the grommets on the corners of the cover, to the front of the body. This enables the carrier to grasp them when the cover is to be put into use (fig. 4-67).

(4) 'The one-man throw is a quick method for spreading a 12- by 18-foot (3.7 by M-meter) cover. It may be used effectively to cover desks, office records, shop machinery, and similar items. First he places the center of the folded cover over his forearm, and grasps the bottom of the fold with the fingers. Then he reaches in next to his body with the other hand and grasps the three folds between the thumb and fingers, with the thumb down. He swings his arm up and over his shoulder and flips the three folds over the back of his hand to give weight to the throw. He brings the hand forward, with the arm still, and throws the cover over the object to be covered with a straight-arm throw. Finally he opens the cover completely and tucks the edges in at the bottom.

(6) Two men should be used to unload the 14- by 18-foot (4.3 by 5.5-meter) cover from the shoulder and place it in use. The carrier grasps the grommet ropes at the cover corners nearest his body, and the second man grasps the remaining ropes and moves away from the carrier. The cover is dropped to the ground and stretched out near the material to be covered. Both men drop the inside edge of the cover, holding firmly to the outside edges. They then raise one edge of the cover quickly, carrying it over the material and allowing the air to balloon the cover, thus enabling the proper placement of the thrown edge. All corners and edges of the cover should be tucked in at the bottom.

(6) The counter payoff is used when material must be covered to prevent its damage, destruction, or disarrangement. The counter payoff is begun by placing the cover over the forearm, holding the bottom fold with the fingers. A second man grasps the top fold and walks backward, both men raising the cover as it unfolds. They place the cover gently over the material. When the cover has been draped, they tuck in the edges at the bottom.

c. ***Other Protective Devices.*** The contents and interiors of buildings may be severely damaged by

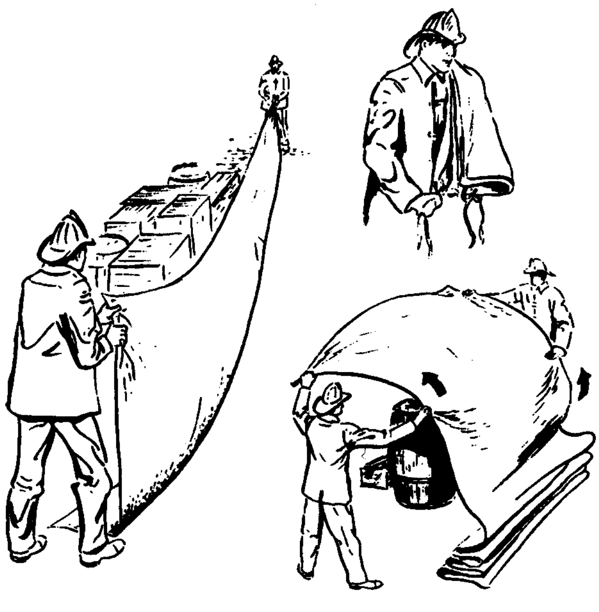

Figure 4-67. Carrying and spreading the large salvage cover.

water dripping through a floor or ceiling in which a drain cannot be made.

(1) To prevent this, improvised basins are frequently needed to catch water which can be removed later by bailing, dumping, or pumping. A catch basin (fig. 4-68) is constructed by placing furniture, boxes, or other equipment in a circle or square beneath the leak. A basin is formed by placing a salvage cover over the furniture and boxes. The cover is fastened to the boxes and furniture or to the door, with the bottom of the basin resting on the floor. Where the quantity of water is not great, shallow catch basins may be made by rolling all four edges toward the cneter. The rolls then form the sides of the basin.

(2) S-hooks, cord, salvage covers, and pike poles can be used to build a chute which directs water through windows, thus protecting contents and interiors of buildings from water damage (fig. 4-69). Light rope or heavy cord can be tied through the grommets to support the covers.

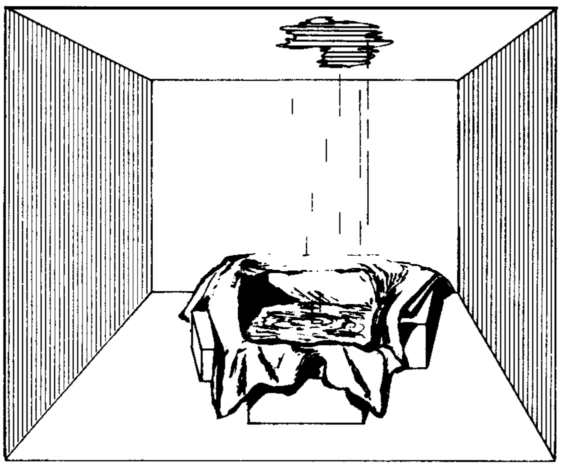

Figure 4-68. Salvage cover basin.

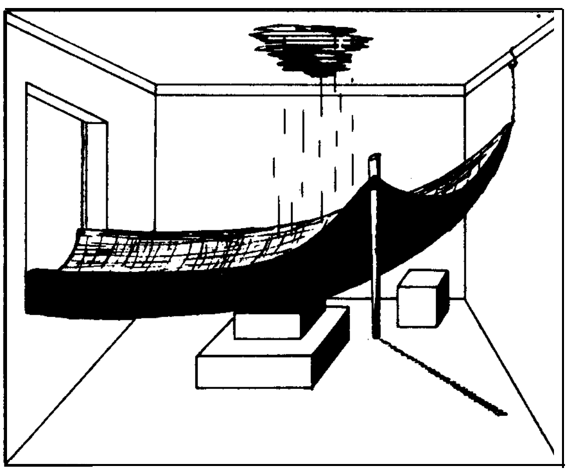

Figure 4-69. Window drain chute.

(3) S-hooks can be improvised from heavy wire, welding rods, or 3/16-inch (0.476-centimeter) cold-rolled steel rods. Rods can be cut to lengths of approximately 8 inches (20 centimeters), sharpened at the ends on a grinding wheel, and bent to an S-shape.

(4) To protect material stored on shelves, the shelf should be covered with the canvas salvage covers. This is down by using S-hooks, nails, and cord to suspend the covers from the walls and the ceiling or by securing the cover with weights. When more than one cover is used, lapovers of about 1 foot (0.305 meter) should be used to prevent leakage.

(5) To protect the interior structures and contents from water damage, stairway drains of canvas covers are frequently needed to direct water from upper floors to a lower level and outside. The two methods of forming stairway drains shown in figure 4-70 are commonly used. Two men and two canvas covers are required to perform the operations efficiently. The first cover is spread by the one-man throw at the bottom of the stairs and fitted to the steps. The second cover is placed at the top of the steps in the same way and is allowed to overlap the lower cover about 1 foot (0.305 meter).

(6) In addition to the tarpaulin or salvage cover, the things most commonly used in salvage work are squeegees, brooms, mops, buckets, pike poles, shovels, and sawdust. Shovels and buckets are used to remove debris. Water is removed from floors with squeegees, mops, buckets, and brooms.

d. Salvage Training. When properly executed, salvage work can often prevent great property

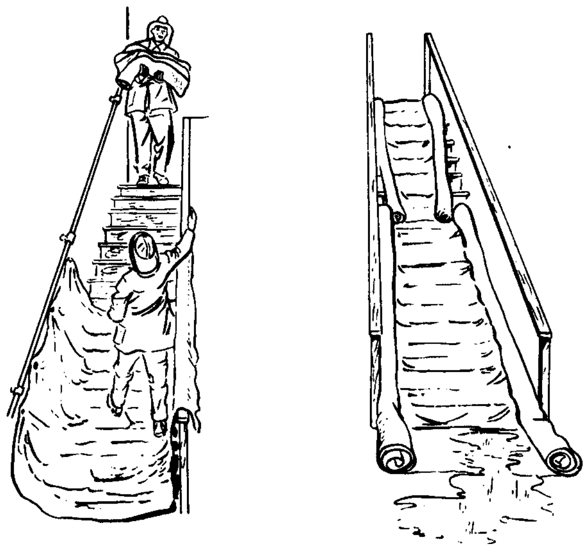

Figure 4-70. Stairway drains.

loss, and invalidate the old theory that firefighters do more damage in putting out a fire than the fire itself does. The folding, throwing, and general handling of salvage covers should be conscientiously practiced under varied conditions until the firefighters can do the job efficiently without hesitation. For practice by two men in a coordinated handling of salvage covers, the fire apparatus itself is an ideal object over which the covers may be thrown. The erection of catch basins, plus any related operations required of the crew, may be set up as part of the salvage and pumper drills.

Section VI. RESCUE OPERATIONS

447. Introduction

The primary function of rescue operations is to perform all emergency procedures that are necessary to recover personnel from situations that prohibit their escape. The first consideration of the firefighter is always that of saving lives. This function may be performed by-(l) recovering victims from hazardous situations, (2) moving victims to a safe place, and (3) giving essential first aid to victims. Whenever possible, the removal of victims to a safe place must be made without further injury. Extreme care must be taken in removing personnel who appear to be injured. Simple fractures, for example, may become compound fractures or may develop into more serious or even fatal injuries unless the victim is moved properly. The different ways of removing casualties are by supporting or carrying, by using a stretcher, and by lowering and raising victims.

4-48. Carries

Helping a victim walk is probably the simplest and easiest of the rescue methods, provided the victim is able to walk at all. This method should not be used unless the rescuer is sure there are no severe injuries that would be aggravated by so doing. Two methods are used, the one-man method and the two-man method.

a. *One-Man Supporting Carry.* To perform the one-man method, an uninjured arm of the victim is placed over the rescuer's shoulder and behind his neck. The rescuer grasps the victim's hand and passes his other arm around the victim's waist (fig. 4-71). In this way the one man may support and help a slightly injured person to walk.

b. *Two-Man Supporting Carry.* The two-man method is similar to the one-man method except that the victim puts an arm over the shoulder and behind the neck of each rescuer. Each grasps his hand and puts the other arm around his waist, thus giving him added support (fig. 4-72). This way practically the entire weight of the victim can be borne by the rescuers.

449. Fireman's Carry

The fireman's carry (fig. 4-73) is the easiest method for one man to carry another. It is accomplished in the following seven steps.

Figure 4-71. Supporting carry.

Figure 4-72. Two-man *supporting carry.*

a. Step 1. Turn the casualty face down and kneel on one knee at his head. Place both hands under the casualty's armpits and gradually work them down the side and across the back.

b. Step 2. Raise the casualty to the knees.

c. *Step 3.* Take a firm hold across the casualty's back.

d Step 4. While holding the casualty around the waist with your right arm, grasp the casualty's right wrist with your left hand and draw his arm over your head. (If the casualty is wounded in such a way that the procedure must be performed from the opposite side, simply change the hand and continue as described, substituting right for left and vice versa.)

e. *Step* 5. Bend at the waist and knees and pull the casualty's right arm down over your left shoulder so that his body comes across your shoulders. At the same time, pass your right arm between his legs and grasp his right knee with your right hand.

f. Step 6. The casualty is lifted as you straighten up.

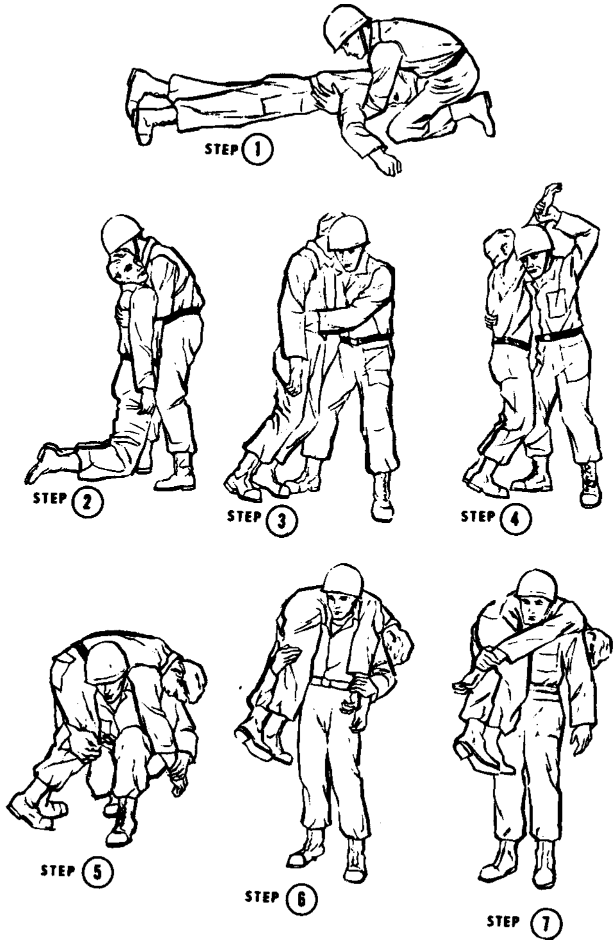

Figure 4-73. Fireman's carry.

g. Step 7'. Then grasp the casualty's right wrist with your right hand, leaving your left hand free. This is the position of carry. A man can carry another some distance in this manner.

4-50. Pack-Strap Carry

Place the pack-strap over the back and under the arms of the victim. Lift the casualty, then turn around while retaining a hold around his body with one arm. Grasp his wrists with your hands and hoist him so that his armpits are over your shoulders (fig. 4-47). This is a good way to carry an unconscious casualty. Do not use it if the casualty has any broken bones. Since both hands are free, the rescuer may proceed down a ladder or through difficult passages. Although the dangling legs of the victim are awkward, he cannot slip from the load. Too, the rescuer can shift the load from his back to his leg muscles by bending forward.

4-5 1. Two-Man Carriers

a. The seat carry is a two-man means of carrying a person. It consists of making a seat rest of one pair of arms and a back rest of the other pair. Figure 4-75 shows how the arms are arranged when completed. The rescuers kneel, one on either side of the victim, near the hips, and raise him to a sitting position steadying him with the arm nearest his head around his back. Each then slips the other arm under the victim's thighs, clasping the wrist of the other. Both arise slowly but in unison, lifting the victim from the ground. When erect, they adjust their upper arms to form a comfortable back rest and to make the victim

Figure 4-75. Arm seat rest.

Figure 4-74. Pack-strap carry.

secure. If conscious, the victim assists the rescuers by grasping each man around the neck.

b. Carrying by the extremities is a good method for carrying a person, hut not usable in case of leg or back injuries. The victim is laid straighton his back, feet apart. One rescuer takes his place between the victim's legs and the other at his head, facing each other. Both men kneel and raise the victim's head and shoulders to a sitting position. The man at the victim's head grasps him from behind, around the body under the armpits. The one between the victim's legs turns around and passes his hands from the outside under the victim's knees, then both rise together and move forward in step (fig. 4-76).

c. A two-man chair-litter carry may be used if a common chair is available. The two men place the victim on the chair, then with one in front and one behind, they grasp the chair conveniently, tip it back, and walk forward in unison, as shown in figure 4-77. The chair serves as a litter.